

# The Contribution of Interdisciplinary Research to Sound Environmental Decision-Shaping in Arctic Matters

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*Interdisciplinary research is a popular methodological choice for informing environmental decision-shaping; however its use needs further critical evaluation to ensure that it is able to meet grand environmental challenges and societal needs. This research provides a historical and conceptual analysis of interdisciplinary environmental decision-shaping in an Arctic context. The primary methodology for the study was interviews with experts who have been engaged with interdisciplinary environmental decision-shaping in the Arctic to answer the research questions: 1) does interdisciplinarity involve the softening of boundaries in the Arctic; 2) does interdisciplinarity promote the diffusion of ideas in the Arctic and 3) does Interdisciplinarity support scientific enquiry in the Arctic? The objective of this research was to further academic inquiry regarding the use of interdisciplinary research in Arctic environmental decision-shaping. Whilst interdisciplinary research in the Arctic was found to encompass a spirit of reinvention, critical thinking and open-mindedness; its use was found to be impacted by geopolitical factors, past and present practices, epistemologies and ontologies including power hierarchies and colonialism. Epistemological differences between actors was seen as a strength in Arctic interdisciplinary studies but required the practitioners to be respectful and willing to re-evaluate their knowledge and approach.*

## An Introduction to Interdisciplinary Environmental Decision-Shaping

Questions concerning whether scientific discovery should be disciplinary and focused or critical and rebellious make up one of the most important questions since the Enlightenment (Coote, 2023). From a Latourian perspective, both politics and science are held within a relationship that means that they exist dependently on one another (Latour, 1988). Interdisciplinarity exists as a fluid concept that straddles science and policy (Osteng, 2009). Discourses surrounding interdisciplinarity can be traced to early Western thinking and have ebbed and flowed in popularity since at least the Platonic era. Interdisciplinary studies gained pace in the twentieth century and recently, interdisciplinary scholarship is booming (Klein, 1990; Osteng, 2009). There is a vast amount of literature concerning interdisciplinarity. However, there is a gap in research which interrogates its

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application, particularly in International Relations and environmental decision-shaping (Jacobs and Frickel, 2009).

The emphasis of this article is on interdisciplinarity which can be defined as: a systems perspective that spans two or more disciplines in order to create a combined methodology (Ostreng, 2009). Disciplinarity refers to the specialisation and fragmentation of academic disciplines since the Enlightenment period (Newell and Green, 1982). Multidisciplinary is also an important concept and can be understood as a working method in which disciplines act separately to achieve a systematic outcome. Transdisciplinary approaches can be understood to integrate numerous approaches and disciplines, or as taking a meta-perspective above disciplines in order to understand concepts. Transdisciplinarity can also be understood as providing a methodology to combine different modes of knowledge (Ostreng, 2009). Different ways of knowing include philosophical knowledge, scientific knowledge, practical knowledge and mystic knowledge which can be applied through using/doing, questioning, analysing and believing (Ostreng, 2010).

There are three constitutional assumptions contained within interdisciplinarity which are interrogated within this article: 1) That interdisciplinarity involves the softening of boundaries; 2) that interdisciplinarity promotes the diffusion of ideas and; 3) interdisciplinarity supports scientific enquiry (Brewer, 1999). Barry and Born (2013) suggest three potential ways in which interdisciplinarity is practised: Mode 1) Integrative approach: the combination of two or more disciplines symmetrically; Mode 2) Subordination-service mode: one discipline occupies a subservient role to the other; Mode 3) Anti-antagonistic: interdisciplinarity is driven by an antagonistic or oppositional relationality to existing knowledge forms. Klein (1990) notes that interdisciplinarity can be practised through four interactions: borrowing, problem solving, increasing consistency of subjects or methods, and the emergence of an inter-discipline.

Interdisciplinarity has been found to present practical challenges including problems arising from epistemological differences between actors; power imbalances within political and scientific structures; and, research difficulties through lack of a fixed methodological blueprint (Jacobs and Frickel, 2009). Power imbalances can be seen through a number of factors. Firstly, some disciplines have more notoriety and funding than others, and secondly, hegemonic discourses may make novel methodology production difficult (Næss, 2010). Methods applied in interdisciplinary studies may be completely new or not following a 'normal' scientific method. Thus, studies have shown some risks to practitioners careers as well as general risks to the project, if the method is incompatible with the overall aim (Lacey and Lacey, 2010).

### **Interdisciplinarity and Environmental Decision-Shaping**

Sustainability science has been characterised by a problem-solving approach which entails more than the disciplines it employs (Boda and Faran, 2018). For example, to solve sustainability issues - economic, environmental, social and political situations need to be considered in unison. As Popper voices: "We are not students of some subject matter but students of problems. And problems may cut right across the borders of any subject or discipline" (Popper, 1963: 88). Trends in environmental decision-making show an international push towards methodologies that are solution-based and pluralistic (Thorén and Persson, 2013).

Sustainability consists of an understanding that sustainable transitions are a process that includes pluralisms and complexities which rely on cross-cutting problem solving (Roe, 2012; Petrov et al.,

2016). Such complexities mean that a diverse group of experts from different epistemological positions are needed to put together the complex puzzle pieces. For example, the 1987 Brundtland Report explains:

“Together, we should span the globe, and pull together to formulate an interdisciplinary, integrated approach to global concerns and our common future... We needed people with wide experience, and from all political fields, not only from environment or development and political disciplines, but from all areas of vital decision-making that influence economic and social progress, nationally and internationally.” (Brundtland, 1987:6)

The notion that environmental problems require complex solutions is tied in with the knowledge that the environment represents a whole rather than parts. This, to a certain extent, stems from a growth in mapping technologies, such as climate modelling, which highlighted the physical and social interrelationships involved in environmental processes, as well as a philosophical shift in academic circles that occurred during this time that highlighted the earth is comprised of a series of integrative feedbacks (see Lockelock, 1979, for example) (Cornell, 2010).

Institutions such as the United Nations integrated interdisciplinarity into their decisions and recommendations on issues of sustainability soon after this shift took place. In 1987, the Brundtland Report called attention to the need for an interdisciplinary approach when considering topics of sustainable development as: “these challenges cut across the divides of national sovereignty, of limited strategies for economic gain, and of separated disciplines of science.” (Brundtland, 1987: 12). Agenda 21 (1992) also specifically promotes the need to increase interdisciplinary research: “In order to integrate demographic analysis into a broader social science perspective on environment and development” (UN, 1992: Chapter 5. p. 1.). The 2012 Sustainable Development Goals (SDGs) recognise the: “need to further mainstream sustainable development at all levels, integrating economic, social and environmental aspects and recognizing their interlinkages” (UN, 2012: 1). The above timeline highlights that in accordance with philosophical and practical trends in international environmental decision-shaping, the United Nations put forward that the environment, economics, society and peace are intrinsically connected and require a cross-cutting approach to sustainability problem-solving, which needs to move beyond disciplinary methodologies.

The Arctic presents an interesting case study regarding the use of interdisciplinary research for sound environmental decision making for a number of reasons. Firstly, knowledge concerning environmental change in the Arctic is linked with a global understanding of earth-systems and the need for an integrative approach to environmental problem solving. Secondly, the Arctic is home to a number of cooperative networks aimed at collaborative science. Thirdly, research into the inclusion of Indigenous Knowledge and Western Science in the Arctic represents a unique discussion concerning broad interdisciplinarity. Finally, environmental change in the Arctic is urgent and thus requires rapid improvements in environmental decision-shaping.

### **Integrative Approaches to Environmental Challenges**

The environmental movement stemmed from a new understanding that industrial and development practices may have damaging repercussions to societal well-being (Haila, & Heininen, 1995). The Love Canal disaster was a key moment in the environmental movement which both

highlighted how conflicting development practices could be dangerous (e.g planning a toxic landfill next to a family housing project) and highlighted that science could be the proof that enables change in collaboration with the business and political sectors (Beck, 1977). Further, the 1983 report *Common Security: a Blueprint for Survival*, led by the Independent Commission on Disarmament and Security Issues, highlights the continuing trend to synthesise the concepts of the environment, security, development and governance against a backdrop of potentially catastrophic nuclear destruction during the Cold War (The Independent Commission on Disarmament and Security Issues, 1983). Today, concerns surrounding climate change have again caused a normative shift calling into question knowledge use and anthropocentric practices (Bhaskar and Parker, 2010).

The Arctic has brought into popular discourse knowledge concerning cause-effect relationships relating to natural systems. For example, melting glaciers and reduced snow cover leads to the albedo effect speeding up global warming. This awareness highlighted the inefficiency of a singular approach to problem solving (Næss, 2010). The Arctic Council (AC) Strategic Plan (2021), shows a desire to integrate broad concepts contained within sustainability. It states: “All people in the Arctic will have ample pathways for sustainable social and economic development while respecting the environment. Conservation and sustainable use of natural resources in the Arctic, that respect the rights and cultures of all Arctic inhabitants, will contribute to resilient societies” (AC, 2021: 1). The concepts of development and conservation are balanced together in a way that requires novel conceptual integration in the search for solutions.

### **Indigenous Knowledge & Western Science**

From a critical perspective, concepts can only be understood in relation to other factors, such as other concepts, past knowledge(s), interests, values, beliefs, power structures and institutions (Gad and Strandsbjerg, 2020; Apetrei et al., 2021). Such concepts are inherently linked to both past colonial activities and current activities within the extractivist paradigm (Sorlin, 2022; Herrmann et al., 2023). From an unorthodox perspective, interdisciplinarity involves “the integration of concepts, methodology, procedures, epistemology, terminology and data” (Organisation for Economic Cooperation and Development, 1972) and; combining epistemological frameworks such as Indigenous Knowledge and Western Science can be seen as an advanced aspect of interdisciplinarity on the evolutionary ladder towards transdisciplinarity (Heckhausen et al., 1970; Thorén and Persson, 2013).

Indigenous Peoples in the Arctic were often forced into the Western centred education system by colonial actors. Such schools taught a disciplinary and segmented way of learning and enforced a new language upon the Indigenous Peoples who were forced to attend (Stuhl, 2019). Arctic science can still be seen to hold colonial practices including inclusion and preference towards Western actors and practices (Herrmann et al., 2023). According to Herrmann et al., (2023): “Acknowledging Indigenous peoples’ right to self-determination in research goes hand-in-hand with rethinking over all ethics in both the natural and social sciences.” Part of this research reflects understanding that science represents certain hegemonic discourses which perforate scientific knowledge and scientific practices favouring certain knowledge(s) and knowledge holders above others. Herrmann et al., (2023) build on the work of Reid et al., (2020) to highlight the concept of two-eyed seeing. The authors write: Two-Eyed Seeing refers to “learning to see from one eye with the strengths of Indigenous ways of knowing, and to see from the other eye with the strengths of

Western ways of knowing, and to use both of these eyes together, for the benefit of all” (Bartlett et al., 2012, s. 335).

### **Cooperation as a Seed for Interdisciplinarity**

Since the Cold War, interdisciplinary studies have provided the backbone of scientific cooperation in the Arctic (Osteng, 2009; Heininen, 2023). The Murmansk speech in 1987 was the catalyst for the development of international networks and programs including the International Arctic Science Committee and the Barents Council (Kökönen, 1996) and multi-actor networks such as the International Arctic Science Committee, the Northern Forum, the Calotte Academy, Conferences of Arctic parliamentarians (Heininen, 2023). Interdisciplinarity was directly cited as a methodological tool in order to achieve shared outcomes. The International Arctic Science Committee’s founding documents, for example, state that: “There is an increasing need for scientific knowledge of the Arctic region... This need comprises many fields of science, and is often of a multidisciplinary or interdisciplinary nature” (IASC, 1990: 2).

INSROP (International Northern Sea Route Programme) commencing in 1993 was an early example of collaborative research between the Arctic states. Osteng (2009: 241) writes that, “for all those who took part in INSROP this interconnectedness became the beauty and the best of interdisciplinarity at the same time”. In 1989, Finland launched the Rovaniemi Process which called for cooperation between the Arctic states on environmental protection. During the meetings in Finland, it was decided that two cross-cutting task forces should be created: one on the Arctic environment and one on Arctic law and cooperation. There were a number of topics to be resolved within each task force, for example, within the environment task forces lay the categories of: “the marine environment, climate change and pollution, radioactivity, chemicals and oil, food chains, waste management, protecting the living resources, environmental economics, environmental health, noise pollution, population centres and indigenous peoples” highlighting the integration of interdisciplinarity in the Arctic immediately after the Cold War ended (Heikkilä, 2019).

This era was marked by an optimism of a ‘New North’ and saw the emergence of numerous networks which sought to encourage collaborative critical thinking on shared issues which naturally adopted a trans-disciplinary approach (Heininen, 2023). Osteng (2009) highlights that the joint desire by the Arctic states to facilitate cooperative mechanisms through scientific collaboration on environmental issues naturally entailed a general approach on cross-cutting issues which was both practical and economically sensible.

### **Methodological Reinvention in Environmental Decision-Shaping**

Much of the debate about interdisciplinarity stems from considerations that disciplines are repressive and inhibit creative problem solving (Barry and Bonn, 2013; Heininen 2018). Gergen (2009) gives voice to such a perspective when he writes: “If innovative scholarship is the outcome of hybridity, of impurity, or blurring the boundaries between disparate realms of reality, disciplining is its enemy. There is no thinking outside the box without risking banishment from the box.” (Gergen, 2009: 210). On the other hand, for some, disciplines are inherently enabling methods and theories that can provide an answer with a wide tool set (Barry and Born, 2013). Another consideration when comparing disciplinarity to interdisciplinarity is that disciplines represent a closed space whereas, interdisciplinarity represents heterogeneity and openness (Barry and Born, 2013). Deleuze gives voice to this concept when he writes: “the individual never ceases passing

from one closed environment to another, each having its own laws: first the family; then the school ("you are no longer in your family"); then the barracks ("you are no longer at school")" (Deleuze, 1992: 1). For some, interdisciplinarity is a staged process which begins in closed disciplinary practices - to multidisciplinary - to interdisciplinarity - to transdisciplinarity (Jantsch, 1970; Thorén and Persson, 2013).

Interdisciplinarity is also a process that is undertaken through the collaboration between many individuals who hold subjective realities. Theorists such as Latour (2007) and Ingold (2012) show the relationality between the scientific practitioner, the material and immaterial world around them as well as their outputs. According to one such thinker, Haraway (1988) - knowledge is situated within complicated frameworks that are performed through practical applications. Haraway (1988) highlights that both the subject and the object should not be considered: 'innocent and waiting outside the violations of language and culture' (Haraway 1988: 109). For Haraway, knowledge is informed by the location and position of the knower and thus, any knowledge produced is therefore not impartial. Haraway (1988) argues that due to this, practitioners should be accountable of how they approach the world around them.

### **Best Practices of Interdisciplinary Projects in the Arctic Council**

The Arctic Climate Impact Assessment (ACIA) (2004) was prepared by the Arctic Monitoring and Assessment Programme (AMAP) in collaboration with the Conservation of Arctic Flora and Fauna (CAFF) working group, and the International Arctic Science Committee (IASC) in order to provide a comprehensive account of Arctic change (AMAP Secretariat, 2023). According to AMAP, "More than 250 scientists and six circumpolar Indigenous Peoples' organisations participated in the ACIA...ACIA was the first comprehensive multidisciplinary assessment of the impacts of climate change in the Arctic. As such it represents a baseline for later work." This was the first comprehensive report to include both the natural and social sciences on Arctic change including "environmental, human health, social, cultural, and economic impacts and consequences, including policy recommendations" (AMAP Secretariat, 2023). Chapter 17 of the ACIA in particular looks to understand the human-environmental system as a whole. For example, the authors write:

"Climate change occurs amid myriad social and natural transformations. Understanding and anticipating the consequences of climate change, therefore, requires knowledge about the interactions of climate change and other stresses and about the resilience and vulnerability of human-environment systems that experience them." (AMAP, 2004: 946).

The Community Based Monitoring Program (CMBP) by CAFF was created based on recommendations from the ACIA and consists of a network of governmental and non-governmental actors including scientists, Indigenous Knowledge holders and conservation groups. The CBMP looks to develop "coordinate and integrated" Arctic Biodiversity Monitoring Plans based around the four key areas of: marine, freshwater, terrestrial and coastal (IPBES, 2018). The CMBP can be applied across all disciplines and geographic areas (CAFF, 2010).

### **Method**

Four interviews were undertaken with knowledge holders who have specialist knowledge on interdisciplinarity in Arctic environmental decision-shaping and science in order to understand whether 1) interdisciplinarity involves the softening of boundaries; 2) interdisciplinarity promotes

the diffusion of ideas; and 3) if Interdisciplinarity supports scientific enquiry (Brewer, 1999). Interviewees were selected due to their expertise on the topic based on publications or professional experience in Arctic environmental decision-shaping and interdisciplinarity. The interviews were semi-structured and based around five broad questions relating to the research questions (Kallio et al., 2016). Sub-questions were asked if an interviewee hit upon a core theme in the research (e.g. scientific cooperation in the Arctic vis-a-vis interdisciplinarity). The research questions were very broad; for example: what makes a good interdisciplinary project? This was to take into account that the interviewer may have potential biases when asking the question and therefore effort was taken not to force a box around the potential answer (De Wachter, 1982). The results were coded based around the topic areas of the research questions (Kallio et al., 2016). Due to the sensitivity of the Arctic research environment since Russia's invasion of Ukraine, all of the participants were kept anonymous of all distinguishing factors and results were edited to take out any specific factor that might show the interviewees identity. The interviewees were not sent the research questions beforehand but were informed that they were under no pressure to answer the questions. Due to time constraints only four interviews were conducted, however they represented a geographical spread across the Arctic and included one Indigenous expert.

## **Results**

### **Interdisciplinarity and the Softening of Boundaries**

Interviewee 3 highlighted that interdisciplinary research caused a reinvention of methodologies. Interviewee 3 stated:

“What makes a really good interdisciplinary project is actually being able to find the points of intersection. Like when you are doing interdisciplinarity often you start from one point of view and tend to work your way out, push the corners out, to incorporate this and that and I really think you have to navigate down the middle. There are really epistemological differences between disciplines and frameworks, so you have to step back and try and sort out what those are...and do it in a way that you get more than you would have done from approaching it from just one perspective... even more than a balancing act it is a reinvention”.

The idea that knowledge is situated geographically and contextually and thus methodologies need to be adapted for specific problems was highlighted by all of the interviewees. For example, Interviewee 1 stated:

“if you use economic methods such as cost and benefit analysis or rational choice theory to solve environmental problems in the Arctic you can get some wrong results because most of the economic methods, they tend to ignore values and they tend to ignore humanitarian aspects because most of the economic methods they aim to the viability of the profits to get a profit or material benefits from a project but as we might know from the Arctic we should think about people living in the Arctic, not about economic effects or economic benefits”.

All interviewees agreed that it was beneficial to get different perspectives to gain insight into a problem set, however there was a mixed understanding of the extent that interdisciplinary work needed to include an international perspective. For example, interviewee 1 stated that:

“it's preferable if its international projects - that projects with different teams from different countries with different methodological approaches would participate. Of course, it's always useful. For example, project x was about country x and at least two foreign teams participated and they brought a lot of useful approaches and methodologies. It is always very good to see a project from an external point of view. Because we are in some kind of internal country x discourse on these issues...we are locked in this discourse and of course we need some kind of fresh ideas and approaches to the problem. It is the same if country y studies region y (in country y) in order to have a more diverse...more objective point of view, it's always good to invite foreign experts with different methodologies and different perspectives on the same problems. So, I believe the international component is quite important”.

Interviewee 3, on the other hand, referenced the need to apply an international perspective to Arctic environmental decision-making rather than just basing science within the region itself. Interviewee 3 stated: “There is a global level too...the little pieces of the whole can't solve the whole problem.”

### **Interdisciplinarity and the Diffusion of Ideas**

Three of the four the interviewees highlighted that good interdisciplinary research should involve the co-production of knowledge. In addition, half of the interviewees highlighted that Indigenous Knowledge (IK) provides a different framework of knowing that science cannot. Interviewee 2 stated that the most successful projects involve a co-production with IK whilst; Interviewee 1 also highlighted that a co-production of knowledge is fundamental to an interdisciplinary project but did not mention specifically that the inclusion of IK is necessary, just relevant Arctic actors.

Interviewee 4 highlighted that interdisciplinary knowledge was mostly seen as a superior methodology within the scientific paradigm which encompasses a narrow following of certain predefined ideas and concepts for reasons of self-interest and adherence to a colonial structure of governance. For interviewee 4, interdisciplinarity still reflects the narrowness of a linearly disposed academic system rather than a holistic knowledge set that can be gained from Indigenous Knowledge. Interviewee 4 evidenced issues with the prevalent education system which pushes a segmented way of learning, detached from the environment, that is disconnected from experientially based learning.

All of the interviewees highlighted that there was a personal dimension to the successful creation of an interdisciplinary project. Interviewee 2 stated:

“It's people really, I mean it doesn't necessarily matter...you can have lots of people who are experts in let's say biology or archaeology and they are looking at some aspect but unless they are open to cooperation across things then it can be quite difficult... if people are open to new ways of thinking and new ideas then a cross-disciplinary project will work really well”.

For interviewee 4, the issue primarily revolved around respect between different knowledge forms. It was not important which actors were present in projects, more that the actors respected each other's ways of knowing.



## **Interdisciplinarity and Scientific Enquiry**

Three of the four interviewees brought attention to the notion that approaching topics from different perspectives can be challenging when not everyone has the same contextual reference. All of the interviewees stated that science should be undertaken from a critical standpoint and highlighted the importance of fluid boundaries around methodological approaches. For example, Interviewee 2 stated:

“You see a lot of people, they may be in similar disciplines, they may be speaking the same language but they are not necessarily understanding one another. So I think transparency, a willingness to admit when you are wrong and an openness to trying something new - they are the basic bones of ensuring (a good interdisciplinary project)”... you may see what you have spent years looking at, from a totally different light... it is an openness and a willingness to change and admit that the approach that has been tried and tested and your particular approach might not be the one that works on a greater scale... to speak a common language is the challenge”.

All interviewees to some extent discussed that science and/or decision-shaping should be relevant for those with a claim to the implications of the research. This was discussed in different ways, through speaking about knowledge ownership, ethics towards nature and societies or rights holders. All of the interviewees highlighted that there was a political dimension to interdisciplinary projects linked to funding prioritisation either for interdisciplinary projects themselves or for certain disciplines over other disciplines. For example, Interviewee 2 said:

“interdisciplinary work is straddling this boundary of how science informs policy because if we look at the EU project they are increasingly requiring that you take an interdisciplinary approach”.

Interviewee 3 said that one of the key problems with interdisciplinary projects is the perceived value of science which leads to the prioritisation of certain discourses over others:

“there is a hierarchy..power structures...it is about who are the powerful voices in academia, who's getting the funding, where is public perception going...what voice is valued...the problem is who has the answers and who are seen as the keepers of knowledge”.

Interviewee 4 highlighted that whilst decision-shaping can include the right statements, for example, the inclusion of IK or the co-production of knowledge...often the decision-making does not reflect that. There were mixed opinions on the extent that interdisciplinary research in the Arctic would be affected by Russia's invasion of Ukraine and the subsequent decline in Arctic cooperation. Interviewee 1, highlighted that the freezing of cooperation since the Ukrainian war has been damaging for interdisciplinary studies on environmental decision-shaping in the Arctic. Interviewee 2 stated: “it is definitely going to affect the quality in that what we will see will only be part of the picture.”

## **Discussion**

Interdisciplinary research methodologies in Arctic environmental decision-shaping merge with a spirit of epistemological cooperation, new academic understandings of the earth as a system and

international environmental decision-making that seeks to balance many different conceptual groupings. This follows the definition of Interdisciplinarity by the Organisation for Economic Co-operation and Development (1972) to understand interdisciplinarity as including “the integration of concepts, methodology, procedures, epistemology, terminology and data”. In the Arctic, interdisciplinarity was used as a political tool to maintain open-minded collaboration after the Cold-War through an integrative approach which combined disciplines towards a mutual goal (environmental protection). Following the work of Barry and Born (2013), this could place Arctic interdisciplinary decision-shaping as anti-antagonistic, which sets interdisciplinary studies as alternatives to epistemologically fixed dialogues and damaging practices of the Cold War. In the Arctic and globally, discourses concerning critical and interdisciplinary methodologies correlate with an understanding of complexities and pluralisms that go beyond a hegemonic discourse and the damaging practices associated with a discourse such as those associated with colonialism or the extractivist paradigm. Considering reflections from Klein (1990) – that interdisciplinarity can be practised through the emergence of an inter-discipline – Arctic studies may reflect an inter-discipline which contains divergent and pluralistic discourses and practices synthesising them through interdisciplinary methodologies or alternatively; environmental decision-shaping could be seen as the inter-discipline with the process of interdisciplinarity as the goal rather than the stated ambition.

A key theme also to be drawn from the research was that the interviewees felt the strength of interdisciplinary research lay in the personal experiences and viewpoints that individual researchers from different backgrounds can bring to the project, including their abilities to respectfully communicate with those from other disciplines or different knowledge sets. For example, interviewee 2 stated: “if people are open to new ways of thinking and new ideas then a cross-disciplinary project will work really well”. The interviewees highlighted that various boundaries could be broken through interdisciplinarity including: methodological, disciplinary, national, individual, historical, political and power based. However, interdisciplinarity also was not seen to be completely removed from concepts and practices surrounding disciplinary. Thus, disciplines were found to represent depositories of situated knowledge entangled within certain predefined understandings of functions and terminologies, as well as sometimes an element of power hierarchies which reflected wider social, political or individual frameworks relating to social order. For example, interviewee 3 stated: “there is a hierarchy... power structures... it is about who are the powerful voices in academia, who's getting the funding, where is public perception going...what voice is valued...the problem is who has the answers and who are seen as the keepers of knowledge”. Looking to Barry and Born (2013), this fits in with the understanding that interdisciplinarity can be practised by entailing an element of ‘subordination-service’ where one discipline dominates the other. This theoretical framework can be expanded to take into account the relationship between different epistemologies, methodologies or practices. Such an analysis could support the work of Herrmann et al., (2023) which argues that Science has historically and currently dominated Indigenous Knowledge in Arctic science.

All of the interviewees considered the relationality of their knowledge and experiences to the world around them and the impact of this on interdisciplinary research. For example, interviewee 1 stated: “Because we are in some kind of internal [country x] discourse on these issues...we are locked in this discourse and of course we need some kind of fresh ideas and approaches to the problem.” For all of the interviewees, knowledge was not seen as impartial. The interviewees all highlighted

the need for open-minded and respectful dialogue and thus, returning to Haraway's theory of Situated Knowledges (Haraway, 1988) - the interviewees highlighted a sense of responsibility for their activities in interdisciplinary science to maintain a critical and constructive dialogue. For example, interviewee 2 stated: "I think transparency, a willingness to admit when you are wrong and an openness to trying something new - they are the basic bones of ensuring (a good interdisciplinary project)".

Based on the topics brought forward by the interviewees from the open questions asked to them, in the Arctic, interdisciplinarity is connected to wide concepts such as (Science, sustainable development, conservation, economics, security and peace) and epistemological frameworks (such as Indigenous Knowledge) rather than purely the integration of two or more disciplines. This is in line with some wider descriptions of interdisciplinarity such as by Heckhausen et al., (1970) and Thorén and Persson (2013).

## Conclusions

This research agrees with a broad definition of interdisciplinarity because to consider current environmental decision-shaping as transdisciplinary would be to accept that methodologies and practices have gone beyond damaging and hegemonic practices to fully explore concepts associated with these practices and, that there has been the equal consideration of different modes of knowing in Arctic science. In the Arctic, interdisciplinary research did involve a softening of boundaries (individual, conceptual, methodological and societal) across disciplinary norms, geographic boundaries and methodological practices dominant within science. Interdisciplinary research was found to correlate with a spirit of reinvention, critical thinking and open-mindedness. This was set against new understandings of complex earth systems in Western philosophy and science; the growth of the environmental movement; improved understandings of the impact of colonisation; the framework of the functionalist environmental agenda of the Arctic states after the Cold War; and internationally in the sustainable development agenda proposed by institutions such as the UN. The research also highlights the negative impact that continued hegemonic practices (e.g colonialism) and closed-minded thinking may have on novel idea generation within environmental decision-shaping. Interdisciplinarity was found to exist in relation to current geopolitics, past histories and power hierarchies, and thus, interdisciplinarity was found to support scientific inquiry only so far as institutional practices, scientific paradigms and individual motivation would allow.

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